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ABSTRACT

This learner's guide on indicator organisms is derived from a water monitoring curriculum developed at Ulster County Community College. There are 37 modules in this guide; each is introduced with a statement of purpose and then broken down into units of instruction. These units contain an objective, learning conditions, and a performance level. The modules cover: (1) safety; (2) scientific notation; (3) laboratory equipment; (4) microbiology; (5) bacteriology; and (6) sample analysis. (CS)

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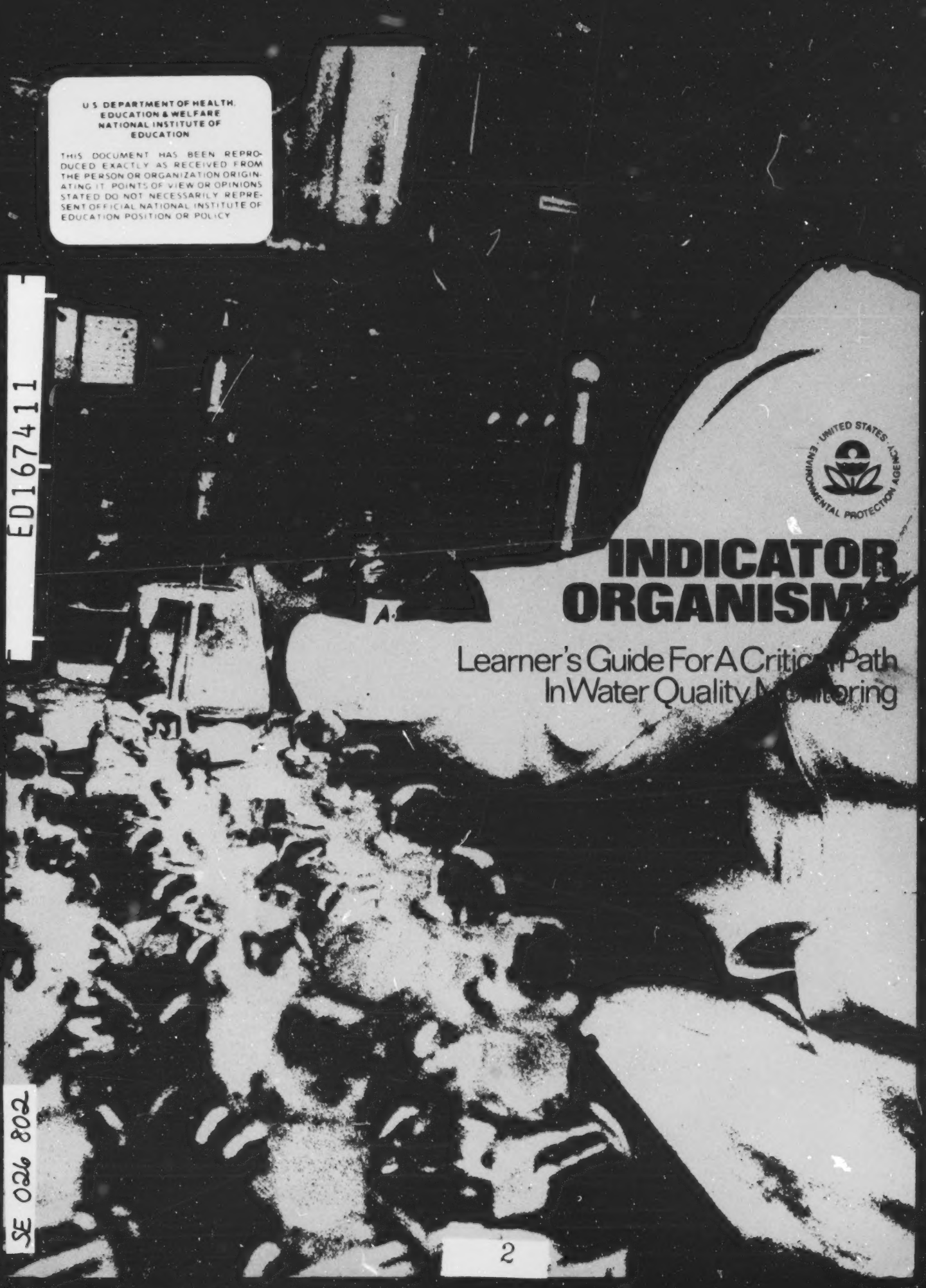

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

INDICATOR ORGANISMS

Learner's Guide For A Critical Path In Water Quality Monitoring

SE 026 802

INDICATOR ORGANISMS

Learner's Guide For A Critical Path In Water Quality Monitoring

February 1979

AWARDED TO

Water Quality Monitoring Project
Ulster County Community College
Stone Ridge, New York 12484

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Dedicated to Anna May Gibbons, a very special assistant whose devotion to this work, personal dedication, and long hours can never be fully repaid.

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Introduction

This learner's guide on indicator organisms is derived from *A Two-Year Water Monitoring Curriculum*, published in 1975 and developed at Ulster County Community College. The entire curriculum was written using the instructional objectives format. One of the many advantages of such a curriculum is the capability it provides for taking its independent learning units (the objectives) out of context and rearranging them in different sequences or courses to meet new or more immediate training needs. The authors of the curriculum and of this learner's guide have designated these sequences as "critical paths."

The critical path in this particular learner's guide leads the trainee to a mastery of the skills necessary for determining indicator organisms. When it becomes necessary to train a technician to conduct these tests, or when the technician or student desires to learn how to conduct these tests on his own, the skills can be developed by mastering the sequenced objectives contained herein.

The objectives found in the instructional modules (courses) in this book, except those dealing with safety procedures, are taken from *A Two-Year Water Quality Monitoring Curriculum.** Because of the importance of correct safety procedures in the laboratory at all times, the authors believe that all critical paths for laboratory procedures should begin with modules on safety.

The mathematics modules, while following the same format as the modules on chemistry and environmental science, contain, in addition, sample solved problems with answers.

The objectives in this critical path for indicator organisms are not strictly theoretical. They have been tested extensively with great success during the past three years in the Water Management Program at Ulster County Community College. The user of this learner's guide can rest assured that the objectives have instructional validity.

The intent of this guide and others in the series that were developed from *A Two-Year Water Monitoring Curriculum* is to take the trainee through the step-by-step sequences required to master very specific sets of skills for very specific job functions. When the instructional objectives are complemented with appropriate audio-visual aids, they provide an almost completely independent, self-paced learning system that offers the instructor the flexibility to become a manager of learning and frees the student from the rigid constraints of more classical, or traditional, educational procedures.

*The environmental science modules are taken directly from the *Learner's Guide: Water Quality Monitoring*, published in June 1978. These modules were also developed from the two-year curriculum.

How To Use This Book

There are thirty-seven courses (or modules) in this guide. Each course is introduced with a statement of purpose, and then broken down into a number of units of instruction, each containing an objective (OBJ), learning conditions (COND), and a performance level (PL).

The statement of purpose is a synopsis of the course material and explains what the student will be studying. It deals with the relevance of the subject material and explains why the student is to master the course skills and knowledge covered in the course. The student should understand why he should master the learning objectives and how the course fits into the total sequence of his learning.

The OBJ tells the student precisely what he must be able to do after mastering each distinct unit of instruction.

The COND tells the student (and the instructor) the circumstances under which the student will perform or the objects, information or assistance the student will have access to while performing. The student should perform under conditions as close to real situations as is practical in the instructional situation.

The PL tells the student the acceptable level of performance that will be required of him to demonstrate mastery of the objective.

Each course (module) is cross referenced to *A Two-Year Water Quality Monitoring Curriculum.** The title of each complete learning module is indicated at the top of the page, with the location in the curriculum coded by curriculum course name and number. The descriptive prefix and the first number refer to the curriculum course in which the module's objectives are found. The second number, following the colon, refers to the number of the pertinent objective in the curriculum, and the third number (in parentheses), is the page in the curriculum on which that objective is found. An example would be:

Math 101:12(44)

This would be read as Mathematics 101, objective 12, page 44 (inequalities) in the two-year curriculum.

*Ulster County Community College, 1975, with the exception of the first three modules on safety.

Courses

Personal Safety

PURPOSE

This guide will help you learn to use safety rules and equipment to protect yourself, others, and the laboratory. Many wait until an emergency happens to learn where equipment is and how to use it. Practicing safety rules eliminates most accidents and minimizes others.

PREREQUISITES

None.

RESOURCES

IRIS: 2911 (Module 1)

OBJECTIVES

OBJ 1: State and use safety rules concerning eyeglasses, lab coats, gloves, and working alone.

COND: From recall.

PL: State all rules in your own words.

OBJ 2: Locate the safety equipment in your laboratory.

COND: Given a stocked laboratory or a sketch or photograph of a lab.

PL: All of the following should be located within 5 minutes:

a. Safety shower
b. First-aid kit and safety sheet
c. Eyewash fountain
d. Fire blanket

OBJ 3: Operate a safety shower and describe how and when to use it.

COND: Given a stocked chemical laboratory or a sketch or photograph of a lab.

PL: Simulate the use of the shower and state when to use it.

OBJ 4: Operate an eyewash fountain.

COND: Given an eyewash fountain, or a sketch or photograph of a fountain, and a towel.

PL: Use of the fountain should be demonstrated for 1 minute, with identification of hazards, such as striking an eye against the fountain.

OBJ 5: Identify the contents of a first-aid kit and describe the use of each item.

COND: Given the kit and an instruction sheet.

PL: Include treatment of:

a. Minor and major heat burns
b. Minor and major chemical burns
c. Minor and major cuts

OBJ 6: Describe or demonstrate the use of a fire blanket.

COND: Given a blanket and an instruction sheet.

PL: Quickly, but without rushing, move to the blanket and follow each step in the instructions within 2 minutes.

OBJ 7: Describe or demonstrate how to smell chemicals and state that chemicals must *never* be tasted.

COND: State from recall and demonstrate, given a bottle of ammonia.

PL: 100%.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Safety glasses	x	x	x	x	x	x	x	
Safety shower		x	x				x	
Eyewash fountain		x		x			x	
First-aid kit		x			x		x	
Fire blanket		x				x		
Ammonia solution							x	

Fire Safety

PURPOSE

This guide will help you learn to handle laboratory fires which may occur. Fires are one of the most common and dangerous accidents which can happen, and prompt action can prevent or minimize damage to people and property.

PREREQUISITES

Before beginning this module you should have successfully completed the previous module on personal safety.

RESOURCES

IRIS: 2911 (Module 2)

OBJECTIVES

OBJ 1: List safety rules for working in the laboratory.

COND: From recall.

PL: State in your own words, including rules about not working alone, using safety glasses, fire prevention, and how to put out and report fires.

OBJ 2: Locate all fire safety features in your laboratory.

COND: Given a stocked laboratory or a sketch or photograph of it.

PL: Locate fire extinguishers, fire blanket, fire alarm, and an escape route.

OBJ 3: Describe how to use CO_2 and dry chemical extinguishers.

COND: Given a stocked laboratory, a type of fire, and an instruction sheet.

PL: Identify:

a. The correct extinguisher for a given type of fire.
b. The safety pin, and how to remove it.
c. The trigger, and how to use it.
d. The portion of the fire to be directly attacked.

OBJ 4: Describe how to set off a fire alarm.

COND: Given a sketch, photograph, or model of a fire alarm.

PL: Include:

a. When to set off an alarm.
b. Never set off a false alarm, and state why.
c. How to leave the building after setting off the alarm.
d. Report to fire chief as soon as he arrives.
e. How to use the fire blanket.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
CO_2 fire extinguisher		x	x					
Dry chemical fire extinguisher		x	x					
Fire blanket		x						
Fire alarm or sketch				x				

Prevention and Treatment of Laboratory Accidents

PURPOSE

This guide will help you learn to prevent laboratory accidents and the proper steps to follow if an accident occurs. Personal injury can be minimized and much time and money saved if proper laboratory skills are used to prevent accidents.

PREREQUISITES

Before beginning this module you should have successfully completed the previous modules on personal safety and fire safety.

RESOURCES

IRIS: 2911 (Mocule 3)

OBJECTIVES

OBJ 1: State basic laboratory safety rules.

COND: From recall.

PL: Include that you must:

a. Wear safety glasses at all times.
b. Wear lab coats or aprons when handling corrosive chemicals.
c. Wear protective shoes.
d. Wear rubber gloves when handling chemicals harmful to the skin.
e. Maintain a clean laboratory.
f. Place hot objects on a protective mat, such as asbestos.
g. Keep chemicals properly labeled and in their appropriate place.

OBJ 2: Describe the purpose of a fume hood and demonstrate its use.

COND: Given a fume hood and an instruction sheet.

PL: The hood should always be used with any volatile chemicals.

OBJ 3: Describe how to dispose of solid and liquid wastes.

COND: From recall.

PL: Description should differentiate between potentially poisonous chemicals and those presenting no health hazard which can be disposed of in water drain or in normal solid waste disposal.

OBJ 4: Describe and demonstrate how to insert glass tubing into rubber tubing or stoppers.

COND: Given a stocked laboratory.

PL: Glass must be fire-polished, lubricated and carefully inserted. Hands must be protected with a towel, and the lubricant must not be chemically reactive with the reagents to be used.

OBJ 5: Describe and demonstrate safety procedures to be followed for basic laboratory skills.

COND: Given a stocked chemical laboratory and instruction sheets.

PL: Include:

a. Always add acid to water, never water to acid.

b. Combine chemicals slowly to prevent overheating if reaction occurs.
c. Remove chemicals from storage containers carefully to prevent accidents and contamination.
d. Proper method of heating glassware.

OBJ 6: Review all safety rules, then describe the proper action to take in case of a specific laboratory accident.

COND: Given the circumstances of an accident involving fire or chemicals in the laboratory or on the body.

PL: Include potential dangers, need for speed, selection of proper protective devices, and describe the steps to be followed to minimize damage.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Fume hood		x						
Beaker		x						
Glass tubing				x				
Rubber tubing or stopper				x				
Towel				x				
Bunsen burner					x			
Wire gauge and ring stand					x			
Ammonia solution (NH_4OH)		x						
6M Sulfuric acid (H_2SO_4)					x			

Inequalities
MATH 101:12 (44)

PURPOSE

This guide will assist you in learning how to use the mathematical concepts of "greater than," "less than," "greater than or equal to," and "less than or equal to." These mathematical concepts and the symbols used to represent these concepts are often found in tables of effluent-influent standards and in NPDES permits.

PREREQUISITES

Before beginning this module you should have successfully completed appropriate high school mathematics courses.

RESOURCES

Algebra texts

OBJECTIVES

OBJ 1: Draw a coordinate line and represent seven points on that line.

COND: Given 2 solved "sample problems," a ruler, 3 negative numbers, 3 positive numbers, and the number zero.

PL: Coordinate line must be properly labeled and the 7 numbers must be represented with 100% accuracy.

OBJ 2: Demonstrate the meaning of the symbols $<$, $\leq$, $>$, and $\geq$ on a coordinate line.

COND: Given 5 solved "sample problems," a ruler, and 10 inequality relationships.

PL: Coordinate line must be properly labeled and 9 out of the 10 inequality relationships must be represented with 100% accuracy.

EQUIPMENT AND SUPPLIES

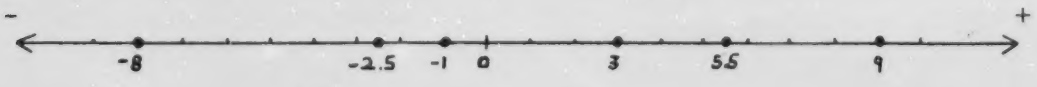
None.

SOLVED SAMPLE PROBLEMS

OBJ 1:

a. Represent the numbers -8, -2.5, -1, 0, 3, 5.5, and 9 on a coordinate line.

Solution:



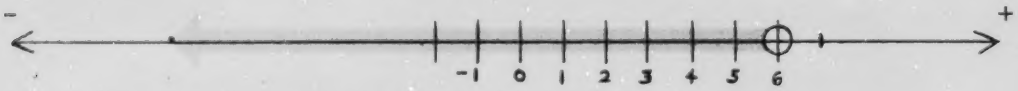
b. Represent the numbers -500, -350, -100, 0, 150, 350, and 450 on a coordinate line.

Solution:

OBJ 2:

a. Represent $x < 6$ on a coordinate line.

Solution:



b. Represent $x \leq 6$ on a coordinate line.

Solution:

c. Represent $x > -4$ on a coordinate line.

Solution:

d. Represent $x \geq -4$ on a coordinate line.

Solution:

e. Represent $x \leq -2$ on a coordinate line.

Solution:

Interconversion of Numbers

MATH 101:28 (46)

PURPOSE

This guide will assist you in learning the method of interconversion of a number from decimal form to scientific notation and back to decimal form again. Scientific notation is particularly useful in generating and recording data when working with indicator organisms.

PREREQUISITES

Before beginning this module you should have successfully completed Math 101:12 (44) and appropriate high school mathematics courses.

RESOURCES

"Exponential Numbers" by Dr. B. P. Stormer
UCCC Media
Ulster County Community College
Stone Ridge, NY 12484

OBJECTIVES

OBJ 1: Convert a number of any magnitude (greater than zero--including decimals less than 1) to a decimal between 1 and 10 by simply moving the decimal point and counting the number of places it is moved.

COND: Given five solved "sample numbers" and 25 unsolved numbers.

PL: The number of places the decimal point is moved must be correct in 80% of the numbers.

OBJ 2: Convert a number of any magnitude to a form ($A \cdot 10^N$), where A is expressed as a decimal between 1 and 10 and N is an integer determined by the number of places the decimal point is moved.

COND: Given five solved "sample numbers" and 25 unsolved numbers.

PL: The forms ($A \cdot 10^N$) must be 80% correct.

EQUIPMENT AND SUPPLIES

None.

SOLVED SAMPLE PROBLEMS

OBJ 1:

a. Convert 1000. to a number between 1 and 10 and count the number of places the decimal was moved.

Solution:

1000. 1.0 is the number decimal moved 3 places

b. Convert 155. to a number between 1 and 10 and count the number of places the decimal was moved.

Solution:

155. 1.55 is the number decimal moved 2 places

c. Convert 0.000039 to a number between 1 and 10 and count the number of places the decimal was moved.

Solution:

0.000039 3.9 is the number decimal moved 5 places

d. Convert 0.00865 to a number between 1 and 10 and count the number of places the decimal was moved.

Solution:

0.00865 8.65 is the number decimal moved 3 places

e. Convert 0.1 to a number between 1 and 10 and count the number of places the decimal was moved.

Solution:

0.1 1.0 is the number decimal moved 1 place

OBJ 2:

a. Convert 1000. to the form $(A \cdot 10^N)$.

Solution:

1000. = 1.0×10^3

b. Convert 155. to the form $(A \cdot 10^N)$.

Solution:

155. = 1.55×10^2

c. Convert 0.000039 to the form $(A \cdot 10^N)$.

Solution:

0.000039 = 3.9×10^{-5}

d. Convert 0.00865 to the form $(A \cdot 10^N)$.

Solution:

$0.00865 = 8.65 \times 10^{-3}$

e. Convert 0.15×10^{-2} to the form $(A \cdot 10^N)$.

Solution:

$0.15 \times 10^{-2} = 1.5 \times 10^{-3}$

Scientific Notation

MATH 101:29 (47)

PURPOSE

This guide will assist you in learning how to simplify multiplication and division using scientific notation. This method of simplification will be particularly useful when working with the dilutions required in indicator organism analysis.

PREREQUISITES

Before beginning this module you should have successfully completed Math 101:12 (44) and 28(46), and appropriate high school mathematics courses.

RESOURCES

"Modumath: 1.9"
New York Network
60 East 42nd Street
New York, NY 10017
"Mini-Courses in Math: Module 6" by
Educational Tutorial Systems
1220 Fifth Street
Santa Monica, CA 90401

OBJECTIVES

OBJ 1: Multiply and divide algebraic terms with exponents.

COND: Given 12 solved "sample problems," the "rules" for multiplication and division of exponents, and 20 unsolved problems.

PL: 90% of the unsolved problems must be solved correctly.

OBJ 2: Use scientific notation to simplify multiplication and division.

COND: Given the "rules" for multiplication and division of exponents, 6 solved "sample problems," and 10 unsolved problems.

PL: 90% of the unsolved problems must be solved correctly.

EQUIPMENT AND SUPPLIES

None.

SOLVED SAMPLE PROBLEMS

OBJ 1:

a. Rule 1: $a^m \cdot a^n = a^{m+n}$

Solved Problems:

$$3^4 \cdot 3^8 = 3^{4+8} = 3^{12}$$

$$2^{-7} \cdot 2^3 = 2^{-7+3} = 2^{-4}$$

$$4^3 \cdot 4^{-7} = 4^{3+(-7)} = 4^{-4}$$

b. Rule 2: $\frac{a^m}{a^n} = a^{m-n}$

Solved Problems:

$$\frac{3^8}{3^4} = 3^{8-4} = 3^4$$

$$\frac{4^3}{4^8} = 4^{3-8} = 4^{-5}$$

$$\frac{2^{-7}}{2^5} = 2^{-7-5} = 2^{-12}$$

c. Rule 3: $a^m = \frac{1}{a^{-m}}$

Solved Problems:

$$3^2 = \frac{1}{3^{-2}}$$

$$4^{-3} = \frac{1}{4^{-(-3)}} = \frac{1}{4^3}$$

d. Rule 4: $\frac{1}{a^m} = a^{-m}$

Solved Problems:

$$\frac{1}{3^2} = 3^{-2}$$

$$\frac{1}{4^{-3}} = 4^{-(-3)} = 4^3$$

e. Rule 5: $a^o = 1$

Solved Problems:

$$3^o = 1$$

$$10^o = 1$$

OBJ 2:

Solved Problems:

a. $\frac{6 \times 10^{8}}{3 \times 10^{4}} = \frac{6}{3} \times \frac{10^{8}}{10^{4}} = 2 \times 10^{8-4} = 2 \times 10^{4}$

b. $\frac{4 \times 10^{-8}}{8 \times 10^{-4}} = \frac{4}{8} \times \frac{10^{-8}}{10^{-4}} = 0.5 \times 10^{-8-(-4)} = 0.5 \times 10^{-4} = 5.0 \times 10^{-5}$

c. $\frac{(6 \times 10^{8})\ (2 \times 10^{4})}{(3 \times 10^{6})} = \frac{6 \times 2}{3} \times \frac{10^{8} \times 10^{4}}{10^{6}}$

$= \frac{12}{3} \times \frac{10^{12}}{10^{6}}$

$= 4 \times \frac{10^{12}}{10^{6}}$

$= 4 \times 10^{12-6}$

$= 4 \times 10^{6}$

d. $\frac{(2 \times 10^{4})\ (4 \times 10^{-6})}{(8 \times 10^{-1})} = \frac{2 \times 4}{8} \times \frac{10^{4} \times 10^{-6}}{10^{-1}}$

$= \frac{8}{8} \times \frac{10^{-2}}{10^{-1}}$

$= 1 \times 10^{-2-(-1)}$

$= 1 \times 10^{-1}$

e. $\dfrac{(6 \times 10^{3})\ (2 \times 10^{-5})\ (5 \times 10^{-2})}{(5 \times 10^{-4})\ (6 \times 10^{-6})} = \dfrac{6 \times 2 \times 5}{5 \times 6} \times \dfrac{10^{3} \times 10^{-5} \times 10^{-2}}{10^{-4} \times 10^{-6}}$

$= \dfrac{60}{30} \times \dfrac{10^{3+(-5)+(-2)}}{10^{-4+(-6)}}$

$= 20 \times \dfrac{10^{-4}}{10^{-10}}$

$= 20 \times 10^{-4-(-10)}$

$= 20 \times 10^{6}$

$= 2 \times 10^{7}$

f. $\dfrac{(2 \times 10^{3})\ (3 \times 10^{4})}{(3 \times 10^{7})} = \dfrac{2 \times 3}{3} \times \dfrac{10^{3} \times 10^{4}}{10^{7}}$

$= \dfrac{6}{3} \times \dfrac{10^{7}}{10^{7}}$

$= 2 \times 10^{7-7}$

$= 2 \times 10^{0}$

$= 2 \times 1$

$= 2$

Laboratory Burners

CHEM 101:46a (36)

PURPOSE

This guide will assist you in learning to use properly laboratory (Bunsen) burners. The Bunsen burner is used routinely in many laboratory tests, and proper techniques are necessary for safety and for attaining reliable lab results.

PREREQUISITES

Before beginning this module you should learn the safety rules for working in the laboratory. (See safety series of objectives.)

RESOURCES

IRIS: 1321 (Chapter 1), 2911 (Modules 1, 2, 3, 11)

OBJECTIVES

OBJ 1: Describe the operation of the Bunsen burner and any other laboratory burners available.

COND: From recall, orally, using the burner at the desk, or a drawing or picture of the burner.

PL: Include:

a. The desk valve
b. The needle valve
c. The air intake
d. The way to light the burner
e. The hottest and cooler regions of the flame
f. How to adjust the flame

OBJ 2: State safety rules which apply to burners and hot objects.

COND: From recall.

PL: Include:

a. Always cut the burner off at the desk valve, *never* at the needle valve.
b. Always check for cracked or brittle rubber tubing.
c. Never place hot objects on metal, asbestos, or wire gauge to cool, never on a wooden desk and never hand them to an instructor.
d. Always fire-polish glass tubing with sharp edges.

OBJ 3: Set up, light, and adjust a laboratory burner.

COND: From recall.

PL: Clear, blue flame should be achieved within 5 minutes.

OBJ 4: Describe and demonstrate the correct method for cutting, bending, and fire-polishing a piece of glass tubing. Explain why these steps are performed.

COND: Given a burner, wing tip, triangular file, 10 inches of soft glass tubing, and an asbestos pad.

PL: Glass tubing must be scratched with one firm stroke of the file, leaving a clearly visible scratch, then smoothly broken with thumbs placed opposite the scratch. Fire-polishing must leave no roughness or constrictions.

A simple bend to $90^{\circ} \pm 10^{\circ}$ must result with no visible constrictions, flattening, or dislocations from the plane of the bend. Also, neither student, instructor, nor table top must be burned with hot glass. The entire operation must require no more than 15 minutes.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Bunsen burner	x		x	x				
Striker or matches			x					
Soft glass tubing				x				
Wing tip				x				
Triangular file				x				
Asbestos pad				x				

Electric Top-Loading Balance

CHEM 101:46f (36)

PURPOSE

This guide will assist you in learning how and when to operate an electric top-loading balance. This is an expensive, fast, easily used balance with an accuracy of ± 1 mg, which is sufficient for most chemical weighing.

PREREQUISITES

None.

RESOURCES

IRIS: 2911 (Module 18)

OBJECTIVES

OBJ 1: Identify the major features of an electric top-loading balance.

COND: Given the balance, or pictures or sketches of this balance.

PL: Include:

a. On-off switch
b. Balance pan
c. Level indicator
d. Level adjust
*e. Pan arrest
f. Zero adjust
g. Tare adjust
h. 10 g optical scale
i. 10 g adjust
j. 0.001 g optical scale
k. 0.001 g adjust

*The pan arrest may not be available on this balance.

OBJ 2: Demonstrate and explain the use of each of the major features of an electric top-loading balance.

COND: Given the balance and resources.

PL: The use of each of the features listed in OBJ 1 should be demonstrated and explained.

OBJ 3: Zero an electric top-loading balance.

COND: Given the balance and resources.

PL: The zero should be reproducible to ± 0.001 g.

OBJ 4: State the rules for using a balance.

COND: Given the balance, or pictures or sketches of this balance.

PL: Include:

a. Make sure the balance is level.
b. Make sure the balance is zeroed.
c. Lock the beam and pans when objects are added or removed from the pans or beam.
d. Keep balance clean and free of chemicals.
e. Never place hot or cold objects on the pan.
f. Place objects to be weighed near the center of the pan.
g. Clean and dust the pan before and after each weighing.
h. Do not lean on the balance table while weighing.

i. Remove all objects and weights, and lock the pan and beam when weighing is completed.
j. Use the same balance for all comparative weighing.
k. Handle objects carefully to prevent changing weights.

OBJ 5: Weigh a solid object and a liquid sample on an electric top-loading balance.

COND: Given the balance, a solid object, a beaker, water, tongs, weighing paper, and resources.

PL: Weights should be accurate to ± 0.002 g, and all rules in OBJ 4 should be followed.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Electric top-loading balance	x	x	x	x	x			
50 or 125 ml beaker					x			
Water					x			
Solid object or sample of solid chemical					x			
Tongs					x			
Weighing paper					x			
Camel's-hair brush				x	x			
Spatula					x			

Double Pan Analytical Balance

CHEM 101:46f (36)

PURPOSE

This guide will assist you in learning to use the double pan analytical balance. The double pan analytical balance is used for very accurate weighings (± 0.1 mg); it is cheaper than electric balances, but is very slow in operation.

PREREQUISITES

None.

RESOURCES

IRIS: 2911 (Module 19)

OBJECTIVES

OBJ 1: Identify the major features of a double pan analytical balance.

COND: Given the balance or pictures or sketches of this balance.

PL: Include:

a. Balance pans
b. Pan arrests
c. Pan arrest knob
d. Beam
e. Beam support
f. Beam support control knob
g. Knife edges
h. Level indicator
i. Level adjust
*j. Rider
*k. Chain
l. Rider or chain control arm and handle
m. Zero adjust screws
n. Pointer
o. Pointer scale
p. Gravity adjustment weight
q. Sliding doors
r. Standard weights

*Some balances may have rider or chain or both.

OBJ 2: Demonstrate and explain the use of the major features of a double pan analytical balance.

COND: Given the balance and resources.

PL: Include each of the features in OBJ 1 and explain in your own words.

OBJ 3: Determine the zero point of your balance.

COND: Given the balance and resources.

PL: Zero point should be close enough to the zero on the scale that the pointer may swing freely. Must be reproducible to ± 0.1 unit on the scale.

OBJ 4: State rules for using a balance.

COND: Given the balance, or pictures or sketches of this balance.

PL: Include:

a. Make sure the balance is level.
b. Make sure the balance is zeroed.
c. Lock the beam and pans when objects are added or removed from the pans or beam.

d. Keep balance clean and free of chemicals.
e. Never place hot or cold objects on the pan.
f. Place objects to be weighed near the center of the pan.
g. Clean and dust the pan before and after each weighing.
h. Do not lean on the balance table while weighing.
i. Remove all objects and weights, and lock the pan and beam when weighing is completed.
j. Use the same balance for all comparative weighing.
k. Handle objects carefully to prevent changing weights.

OBJ 5: Weigh a solid object and a liquid sample on the double pan analytical balance.

COND: Given a solid object, a beaker, water, tongs, weighing paper, the balance, and resources.

PL: Weights should be accurate to ± 0.2 mg, and all rules in OBJ 4 should be followed.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Double pan analytical balance	x	x	x	x	x			
50 ml beaker or weighing bottle					x			
Water					x			
Solid object or sample of solid chemical					x			
Tongs					x			
Weighing paper					x			
Set of standard weights					x			
Tweezers or forceps					x			
Spatula					x			
Camel's-hair brush				x	x			

Triple Beam and Double Pan Balances

CHEM 101:46f (36)

PURPOSE

This guide will assist you in learning how to use and care for triple beam and double pan balances. These are simple and quick to use and are sufficiently accurate for many routine weighings (those which require accuracy of only 0.1 g or, at most, 0.01 g).

PREREQUISITES

None.

RESOURCES

IRIS: 2911 (Module 17)

OBJECTIVES

OBJ 1: Identify the major features of triple beam and double pan balances.

COND: Given the balances, or pictures or sketches of these balances.

PL: Include:

a. Beams
b. Balance pans
*c. Level indicator
*d. Beam arrest (lock)
e. Pan arrest (lock)
f. Zero adjust
g. Reference weights
h. Pointer
i. Fulcrum (knife edge)
j. Relative precision

*Often not found on these balances.

OBJ 2: State the rules for using a balance.

COND: Given the balances, or pictures or sketches of these balances.

PL: Include:

a. Make sure the balance is level.
b. Make sure the balance is zeroed.
c. Lock the beam and pans when objects are added or removed from the pans or beam.
d. Keep balance clean and free of chemicals.
e. Never place hot or cold objects on the pan.
f. Place objects to be weighed near the center of the pan.
g. Clean and dust the pan before and after each weighing.
h. Do not lean on the balance table while weighing.
i. Remove all objects and weights, and lock the pan and beam when weighing is completed.
j. Use the same balance for all comparative weighing.
k. Handle objects carefully to prevent changing weights.

OBJ 3: Weigh a solid object on the triple beam and double pan balances.

COND: Given an object, the balances, tongs, and resources.

PL: Weights should be accurate to ± 0.1 or ± 0.01 g, depending upon accuracy of the balance. All rules in OBJ 2 should be followed.

OBJ 4: Weigh a liquid sample on the triple beam and double pan balances.

COND: Given a beaker, water, the balances, tongs, and resources.

PL: Weights accurate to ± 0.1 or ± 0.01 g, depending upon the accuracy of the balance. All rules in OBJ 2 should be followed.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Triple beam balance	x	x	x	x				
Double pan balance	x	x	x	x				
Tongs			x	x				
250 ml beaker				x				
Solid object or sample or solid chemical (for example, NaCl)			x					
Water				x				
Camel's-hair brush		x	x	x				
Set of reference weights		x	x	x				
Spatula			x					

Electric Single Pan Analytical Balance

Chem 101:46f (36)

PURPOSE

This guide will assist you in learning to use an electric single pan analytical balance. Many tests require accuracy of ± 0.1 mg, which is only possible with analytical balances. The electric single pan analytical balance is expensive, but easy and quick to use.

PREREQUISITES

None.

RESOURCES

IRIS: 2911 (Module 20)

OBJECTIVES

OBJ 1: Identify the major features of an electric single pan analytical balance.

COND: Given the balance, or pictures or sketches of this balance.

PL: Include:

a. Balance pan
b. Level indicator
c. Level adjust
d. Pan arrest
e. Zero adjust
f. Tare adjust
g. Weight control for 100 g, 10 g, 1 g
h. Micrometer control for fractions of grams
i. Optical scales for reading 100 g, 10 g, 1 g, and fractional mg weights
j. Sliding door

OBJ 2: Demonstrate and explain the use of each of the major features of an electric single pan analytical balance.

COND: Given the balance and resources.

PL: Use of each of the features listed in OBJ 1 should be demonstrated and explained.

OBJ 3: Zero an electric single pan analytical balance.

COND: Given the balance and resources.

PL: Zero should be reproducible to ± 0.1 mg.

OBJ 4: State the rules for using a balance.

COND: Given the balance, or pictures or sketches of this balance.

PL: Include:

a. Make sure the balance is level.
b. Make sure the balance is zeroed.
c. Lock the beam and pans when objects are added or removed from the pans or beams.
d. Keep balance clean and free of chemicals.
e. Never place hot or cold objects on the pan.
f. Place objects to be weighed near the center of the pan.
g. Clean and dush the pan before and after each weighing.
h. Do not lean on the balance table while weighing.
i. Remove all objects and weights, and lock the pan and beam when weighing is completed.

j. Use the same balance for all comparative weighing.
k. Handle objects carefully to prevent changing weights.

OBJ 5: Weigh a solid object and a liquid sample on an electric single pan analytical balance.

COND: Given the balance, a solid object, a beaker, water, tongs, weighing paper, and resources.

PL: Weights should be accurate to ± 0.2 mg, and all rules in OBJ 4 should be followed.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Electric single pan analytical balance	x	x	x	x	x			
50 ml beaker or weighing bottle					x			
Water					x			
Solid object or sample of solid chemical					x			
Tongs					x			
Weighing paper					x			
Spatula					x			
Camel's-hair brush				x	x			

Laboratory Ovens

ENV SCI 101:1b(49)

PURPOSE

This guide will assist you in learning to operate a laboratory oven for drying glassware, for preparing standard reagents by drying off moisture from their solid forms, and for sterilization. These drying operations at 50°C to 200°C are necessary to give accurate weighings for many tests.

PREREQUISITES

Before beginning this module you should have successfully completed the modules on Balances (Env Sci 101:1a) and Desiccators (Env Sci 101:1c), and you should be able to use a Celsius thermometer [Chem 101:46b(36)].

RESOURCES

IRIS: 2911 (Module 13)

OBJECTIVES

OBJ 1: Identify the major features of a laboratory oven.

COND: Given the oven or photographs or sketches of it.

PL: Include:

a. Temperature control
b. Thermometer or temperature gauge
c. On-off control
d. Door latch
e. Shelving and shelf-adjustment

OBJ 2: Adjust the shelves of an oven for small or large glassware.

COND: Given the oven and several short and tall beakers or flasks.

PL: Glassware should not touch a second shelf, but there should be no more than 5 cm excess height.

OBJ 3: Operate an oven at a given temperature.

COND: Given the oven, the temperature, and resources, including the operations manual for your oven.

PL: Standardize the temperature control settings with a thermometer, then set to ± 1°C using the standard form.

OBJ 4: Add and remove from a hot oven different items of glassware and crucibles.

COND: Given an equipped laboratory and resources.

PL: Use crucible and beaker tongs to prevent burns, spillage, breakage or contamination.

OBJ 5: Heat a solid sample to constant weight in an oven.

COND: Given an equipped laboratory and resources.

PL: Correct weight should be reproduced to ± 1% in 3 consecutive weighings.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Drying oven	x	x	x	x	x			
Beaker (250 ml)		x		x				
Erlenmeyer flasks (50 and 125 ml)		x		x				
Tongs				x				
Crucible				x				
Asbestos pad				x	x			
Weighing bottle or 50 ml beaker					x			
Desiccator					x			
Barium chloride ($BaCl_2 \cdot 2H_2O$)					x			

Desiccators

ENV SCI 101:1c(49)

PURPOSE

This guide will assist you in learning how to empty, refill, and lubricate a desiccator and how to handle it to transport hygoscopic substances. The desiccator is used to prevent such samples from picking up water from the atmosphere.

PREREQUISITES

Before beginning this module you should be able to name and use laboratory glassware.

RESOURCES

(To be provided by instructor.)

OBJECTIVES

OBJ 1: Identify and describe the use of the major features of a desiccator.

COND: Given a desiccator or a picture or sketch of a desiccator.

PL: Include the names of two or more desiccants, the techniques for transporting and storing hygoscopic substances, and the purpose of the crucible holder plate.

OBJ 2: Empty, clean, and refill a desiccator with desiccant.

COND: Given the desiccator, clean towels, and the desiccant.

PL: Refilled desiccator should have no adhering particles which could contaminate items to be dried. Desiccant should reach to about 2 cm of the crucible holder plate.

OBJ 3: Clean and regrease the desiccator and lid.

COND: Given an equipped laboratory.

PL: A thin, even layer of grease should give a firm, air-tight seal which does not easily slip.

OBJ 4: Place a hot crucible and lid in the desiccator, and retrieve them when cool.

COND: Given an equipped laboratory.

PL: Crucible lid should be placed beside the crucible, not on it. No contamination should occur from grease or disiccant, and the desiccator lid should be *carefully* removed and replaced to avoid breakage.

OBJ 5: Transport a crucible and lid in a desiccator.

COND: Given a desiccator, crucible, and lid.

PL: Lid must be held firmly and contents not disturbed during transport.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Desiccator	x	x	x	x	x			
Desiccant (e.g., silica gel)	x	x	x	x	x			
Towel		x	x					
Solvent (e.g., acetone)			x					
Stopcock grease			x					
Crucible and lid				x	x			
Tongs				x				

Muffle Furnaces

ENV SCI 101:1d(49)

PURPOSE

This guide will assist you in learning to use a muffle furnace to decompose a solid sample to give a constant weight. Many laboratory tests require heating at temperatures of 200° to 600°C in such a furnace.

PREREQUISITES

Before beginning this module you should have successfully completed Balances 101:1a, Desiccators 101:1c, and Ovens 101:1b.

RESOURCES

IRIS: 2911 (Module 13)

OBJECTIVES

OBJ 1: Identify the major features of a muffle furnace.

COND: Given the muffle furnace or pictures or sketches of it.

PL: Include:
- a. On-off switch
- b. Temperature control
- c. Temperature scale
- d. Pilot light
- e. Door handle
- f. Work shelf

OBJ 2: Operate a muffle furnace at a given temperature.

COND: Given the muffle furnace, resources, and the operations manual.

PL: Temperature must be ± 10°C of chosen value. (If the furnace has no standard scale, it may be necessary to standardize the furnace.)

OBJ 3: Add and remove a crucible from a hot furnace.

COND: Given an equipped laboratory and resources.

PL: Addition and removal should be done without breakage, contamination or burns.

OBJ 4: Heat a sample to constant weight.

COND: Given an equipped laboratory and resources.

PL: Three consecutive weighings should be within ± 0.4 mg of the correct weight.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Muffle furnace	x	x	x	x				
Crucible with lid			x	x				
Tongs			x	x				
Asbestos glove			x	x				
Desiccators			x	x				
Analytical balance				x				
Calcium bicarbonate [$Ca(HCO_3)_2$]				x				
Fume hood		x	x	x				

Hot Plates

ENV SCI 101:1e(49)

PURPOSE

This guide will assist you in learning to use the hot plate, which is the most commonly used electrical heating device in the laboratory. The hot plate is a simple and quick device for heating samples, but does not give a well controlled temperature. It is safer than an open flame for heating combustible materials.

PREREQUISITES

Before beginning this module you should be able to use a Celsius thermometer [Chem 101:46b(36)].

RESOURCES

IRIS: 2911 (Module 12)

OBJECTIVES

OBJ 1: Identify the major features of a hot plate.

COND: Given a hot plate or pictures or sketches of it.

PL: Include:

a. On-off control
*b. Stirrer speed control
c. Temperature control
d. Pilot light
e. Plate

OBJ 2: Calibrate the temperature control dial.

COND: Given an equipped laboratory and resources.

PL: Temperature should be reproducible to ± 5°C at 100°C.

OBJ 3: Boil a liquid sample on the hot plate.

COND: Given an equipped laboratory and resources.

PL: Water should boil smoothly at the setting corresponding to 100°C.

*Some hot plates include a magnetic stirrer.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Hot plate	x	x	x					
Celsius thermometer		x	x					
Mineral oil (high boiling point)		x	x					
Beaker (250 ml)		x	x					
Boiling stones			x					
Water			x					

Hoods

ENV SCI 101:1(49)

PURPOSE

This guide will assist you in learning how to use the hood to prevent accidents, since many tests generate gases or fumes that can harm both the experimenter and equipment.

PREREQUISITES

None

RESOURCES

IRIS: 2911 (Module 3)

OBJECTIVES

OBJ 1: Identify the major features of a fume hood.

COND: Given a hood or pictures or sketches of a hood.

PL: Include:

a. Sliding glass shield
b. Outlets and controls for gas, water, and air
c. Workbench top
d. Electrical outlet
e. Electrical on-off switch
f. Drain

OBJ 2: Operate the fume hood and each of the features of the hood.

COND: Given the hood, NH_4OH, beaker, and resources.

PL: All systems should work.

OBJ 3: Test for suction from the hood.

COND: Given the hood, matches, and resources.

PL: With hood switch on and the shield up, match should not go out. With the hood up about 5 cm, match should be blown out.

OBJ 4: Identify the kinds of procedures which should be carried out in the hood.

COND: Given a list of procedures, including ones involving noxious gases such as NO_2, H_2, and Cl_2

PL: All listed procedures requiring the hood must be identified.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Hood	x	x	x					
Ammonium hydroxide (NH_4OH)		x						
Beaker		x						
Matches			x					
List of procedures				x				

Water Stills

ENV SCI 101:1g(49)

PURPOSE

This guide will assist you in learning to use the water still and keep it in operation. Water stills provide water which is free of most of the chemicals found in tap water, and distilled water is necessary for most laboratory tests.

PREREQUISITES

None

RESOURCES

(To be provided by instructor.)

OBJECTIVES

OBJ 1: Identify the major features of a still.

COND: Given the still or pictures or sketches of it.

PL: Include:

a. On-off switch
b. Water inlet
c. Condenser
d. Water drain
e. Safety valve
f. Storage container

OBJ 2: Operate and perform routine maintenance on a still.

COND: Given the still, resources, and the operations manual.

PL: Turn water on, turn switches on, adjust condenser water for smooth flow, check regularly, and clean when solids build up (this can decrease efficiency).

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Water still	x	x						

pH Meters

ENV SCI 101:1h(49)

PURPOSE

This guide will assist you in learning to adjust, operate, and care for a pH meter. The pH meter is a fast, accurate instrument for measuring the acidity (or basicity) and pH of a solution.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 101:2a and Chem 101:46b(36).

RESOURCES

IRIS: 404, 1063, 1762, 2110, 2122

OBJECTIVES

OBJ 1: Identify the major features of a pH meter.

COND: Given the pH meter or pictures or sketches of it.

PL: Include:

a. On-off switch
b. Temperature adjust
c. Scale adjust
d. pH scale
e. pH electrode
f. Reference electrode
g. Electrode connectors
h. Stand-by knob

OBJ 2: Read the pH scale.

COND: Given the pH meter or pictures or sketches of it.

PL: Read to ± 0.01 unit.

OBJ 3: Standardize the pH meter.

COND: Given the pH meter, two buffer solutions, water, beakers, thermometer, and resources.

PL: Adjust for temperature and buffers to ± 0.01 pH unit, rinsing electrodes after each measurement.

OBJ 4: Determine the pH of a sample.

COND: Given the pH meter, two buffer solutions, beakers, water, thermometer, sample, and resources.

PL: Sample pH should be within ± 0.02 pH units of correct value.

OBJ 5: Clean the electrodes and prepare for temporary storage.

COND: Given the pH meter, beakers, distilled water, and dust cover.

PL: Electrodes should be rinsed and suspended in distilled water, dust cover left in place, and meter left "on stand-by" or "off."

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
pH meter	x	x	x	x	x			
Buffer solutions covering a range of 5 to 7 pH units			x	x				
Beaker			x	x	x			
Distilled water			x	x	x			
Thermometer			x	x				
Sample, with known pH				x				

Spectrophotometers

ENV SCI 101:1I(49)

PURPOSE

This guide will assist you in learning to use the spectrophotometer. Many chemical laboratory tests depend on the spectrophotometer to read accurately the intensity of color of a solution at a given wavelength.

PREREQUISITES

Before beginning this module you should be able to use laboratory glassware (beakers, test tubes, and graduated cylinders), and use metric volumes.

RESOURCES

IRIS: 850, 1061, 1062

OBJECTIVES

OBJ 1: Identify the major features of a spectrophotometer.

COND: Given the spectrophotometer or pictures or sketches of it.

PL: Include:

a. On-off switch
b. Sample compartment
c. Cuvette
d. Absorbance and transmittance scales
e. Zero adjust
f. 100% adjust
g. Wavelength control
h. Photo tube
i. Filter

OBJ 2: Read the scales on the spectrophotometer.

COND: Given the spectrophotometer or pictures or sketches of it.

PL: Reading should be to ± 2% transmittance.

OBJ 3: Adjust the wavelength of a spectrophotometer.

COND: Given the spectrophotometer and a stated wavelength.

PL: Wavelength should be correct to within ± 1 unit.

OBJ 4: Zero the spectrophotometer.

COND: Given the spectrophotometer, a cuvette, water blank, resources, and operations manual.

PL: Zero should be reproducible to ± 2%.

OBJ 5: Adjust the 100% transmittance scale.

COND: Given the spectrophotometer, a cuvette, water, resources, and the operations manual.

PL: 100% mark should be reproducible to ± 2%.

OBJ 6: Read the absorbance and transmittance of a sample.

COND: Given the spectrophotometer, resources, a cuvette, water blank, a sample solution, the operations manual, and a wave length.

PL: Adjust the zero and 100% scales and the wavelength, then read to absorbance and transmittance to within ± 2% of the correct value.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Spectrophotometer	x	x	x	x	x	x		
Cuvette				x	x	x		
Distilled water				x	x	x		
Sample solution with known absorbance						x		

Autoclaves

ENV SCI 101:1j(49)

PURPOSE

This guide will assist you in learning to use and identify the component parts of the autoclave, which is used to sterilize equipment to be used in biological tests.

PREREQUISITES

None

RESOURCES

(To be provided by instructor.)

OBJECTIVES

OBJ 1: Identify the major features of an autoclave.

COND: Given the autoclave or pictures or sketches of an autoclave.

PL: Include:

a. On-off switch
b. Steam control
c. Pressure gauge
d. Safety valve
e. Temperature control
f. Temperature gauge
g. Door latch
h. Timer
i. Shelves

OBJ 2: Use the autoclave to sterilize glassware.

COND: Given the autoclave, beakers, tongs, resources, and stated temperature, pressure, and time.

PL: Pressure gauges should record the necessary pressure to ± 5% and the necessary temperature to ± 5°C.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Autoclave	x	x						
Beaker		x						
Tongs		x						

Graduated Cylinders

ENV SCI 101:2a(49)

PURPOSE

This guide will assist you in learning when and how to use graduated cylinders, which are used to measure and transfer volumes of liquids quickly and with moderate accuracy.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:37 (35).

RESOURCES

IRIS: 2105, 2911 (Module 8)

OBJECTIVES

OBJ 1: Identify the characteristic features of a graduated cylinder.

COND: Given a graduated cylinder or pictures or sketches of one.

PL: Include:
a. Total volume
b. Volume represented by each mark
c. Approximate accuracy
d. Statement of its use, in your own words

OBJ 2: Clean a graduated cylinder.

COND: Given a graduated cylinder, brush, detergent, rubber gloves, chromic acid cleaning solution, and distilled water.

PL: Water should drain smoothly from the walls, with no clinging droplets.

OBJ 3: Using the lower part of the meniscus, read the volume of liquid contained in a graduated cylinder.

COND: Given a graduated cylinder holding a liquid or pictures or sketches of this.

PL: ± 0.5 ml for 100 ml cylinder or smaller.

OBJ 4: Transfer a given volume of liquid using a 100 ml graduated cylinder.

COND: Given a graduated cylinder, water, and a stated volume to be transferred.

PL: ± 0.5 ml.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Graduated cylinders (volumes from 10 to 100 ml)	x	x	x	x				
Test tube brush		x						
Detergent		x						
Rubber gloves		x						
Chromic acid solution		x						
Distilled water		x	x	x				

Volumetric Flasks

ENV SCI 101:2b(49)

PURPOSE

This guide will assist you in learning when and how to use volumetric flasks. These are used to prepare solutions that require great accuracy and precise volumes, and they require more time to use than a graduated cylinder.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 101:1a and Chem 101:37(35).

RESOURCES

IRIS: 2105, 2911 (Module 8)

OBJECTIVES

OBJ 1: Identify the characteristic features of volumetric flasks.

COND: Given volumetric flasks or pictures or sketches of them.

PL: Include:

a. Total volume
b. Temperature at which volume measurement is accurate
c. Approximate accuracy
d. Mark identifying total volume
e. Stopper or plug
f. Statement of its use, in your own words

OBJ 2: Clean a volumetric flask.

COND: Given a flask, distilled water, detergent, a brush, chromic acid solution, and rubber gloves.

PL: Water should drain smoothly from the walls, leaving no clinging droplets.

OBJ 3: Correctly fill a volumetric flask to the mark.

COND: Given the volumetric flask, water, and a medicine dropper.

PL: The bottom of the meniscus should occur at the mark in 3 consecutive tries.

OBJ 4: Prepare a solution of known concentration.

COND: Given the volumetric flask, a weighed sample of salt, water, and a medicine dropper.

PL: Procedures for dissolving, mixing, and adding liquid to mark should be demonstrated.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Volumetric flask (any volume from 25 to 1000 ml)	x	x	x	x				
Test tube brush		x						
Detergent		x						
Rubber gloves		x						
Chromic acid solution		x						
Medicine dropper or pipet			x	x				
Sodium chloride (NaCl)				x				
Balance				x				

Volumetric and Measuring Pipets

ENV SCI 101:2c(49)

PURPOSE

This guide will assist you in learning to use both volumetric and measuring (Mohr) pipets for laboratory tests in which specific volumes of liquids must be measured and transferred quickly and accurately to ± 0.01 ml.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:37 (35).

RESOURCES

IRIS: 404, 2105, 2106, 2534, 2911 (Module 10)

OBJECTIVES

OBJ 1: Identify volumetric and measuring (Mohr) pipets and identify the major features of each.

COND: Given the pipets or pictures or sketches of them.

PL: Identify:

a. Volume represented by each mark
b. Total volume
c. Bulb
d. TD (to deliver) or TC (to contain)

OBJ 2: Transfer volumes of liquids with volumetric pipets.

COND: Given the pipets, beakers, water, a volumetric flask, and a bulb or aspirator.

PL: For 50 ml or less, the accuracy must be ± 0.05 ml.

OBJ 3: Transfer specific volumes of liquid with a pipet.

COND: Given the pipet, beakers, water, and a volumetric flask.

PL: Volumes, including fractions of ml, should be delivered to the nearest 0.05 ml. Technique should be evaluated by delivery into a standard solution with proper indicator.

OBJ 4: Clean pipets.

COND: Given pipets, beakers, water, detergent, chromic acid, rubber gloves, and resources.

PL: Water should drain cleanly, leaving no droplets clinging to the walls.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Volumetric pipet (5, 10, 20, 25 or 50 ml)	x	x		x				
Mohr pipet (5, 10, 20 or 25 ml)	x		x	x				
Volumetric flask (same volume as pipets)		x	x					
2 beakers (100 or 250 ml)		x	x	x				
Detergent				x				
Rubber gloves				x				
Chromic acid solution				x				

The Care and Use of Burets

ENV SCI 101:2d(49)

PURPOSE

This guide will assist you in learning to use the buret, which is needed in many laboratory tests that require the addition of liquids carefully, in small increments and accurate to ± 0.01 ml.

PREREQUISITES

Before beginning this module you should have successfully completed Chem 101:37 (35).

RESOURCES

IRIS: 285, 1143, 2105, 2127, 2911 (Module 9)

"How to Titrate Using a Buret," audio-visual material prepared by American Institute of Biological Sciences, Project BIOTECH.

OBJECTIVES

OBJ 1: Identify the characteristic features of burets.

COND: Given the buret or pictures or sketches of it.

PL: Include:

a. Barrel
b. Volume represented by each mark
c. Total volume
d. Tip
e. Type of stopcock, stating whether it is suitable for acid and alkaline solutions
f. Stopcock fastener

OBJ 2: Lubricate a glass stopcock.

COND: Given a buret with glass stopcock, stopcock grease, acetone, towels, and thin copper wire.

PL: Remove all old grease from the stopcock and lubricate with a thin layer of fresh stopcock grease. (There should be no grease in the tip; if there is, remove it.) Stopcock should turn smoothly without binding or slipping, and no grease should plug the hole.

OBJ 3: Read the volume of liquid in a buret.

COND: Given a buret, a beaker, and water.

PL: Read to ± 0.01 ml.

OBJ 4: Fill a buret and deliver a prestated volume of liquid.

COND: Given a buret, water and beakers, and a funnel.

PL: Fill without spilling and remove all air bubbles. Deliver accurately to ± 0.01 ml.

OBJ 5: Fill, zero, and deliver liquid accurately with an automatic buret.

COND: Given the buret, beakers, and water.

PL: Accurate to ± 0.01 ml.

OBJ 6: Perform a titration.

COND: Given burets, flasks, funnel, standard solution, an indicator, an "unknown" acid solution, and a procedure.

PL: Three consecutive titrations should vary no more than 0.01 ml. Each titration should require less than 10 minutes, including filling the burets.

OBJ 7: Clean burets.

COND: Given the glassware, buret brush, detergent, chromic acid, and rubber gloves.

PL: The glassware should drain clean, with no droplets of water clinging to the walls.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Buret: Glass stopcock	x		x	x		x	x	
Buret: Teflon or glass stopcock		x						
Buret: Automatic buret					x			
Stopcock grease		x						
Acetone		x						
Towels		x						
Copper wire (thin)		x						
2 beakers (250 ml)			x	x	x	x	x	
Funnel				x		x		
2 Erlenmeyer flasks (250 ml)						x		
Standard NaOH (0.100N)						x		
Sulfuric acid (H_2SO_4) solution (about 0.1N)						x		
Phenolphthalein						x		
Detergent							x	
Buret brush							x	
Chromic acid solution							x	
Rubber gloves							x	

Serial Dilution

ENV SCI 101: 3a (49)

PURPOSE

This guide will assist you in learning to perform a serial dilution on a water sample. This procedure is designed to reduce the quantity of a substance or microorganism to a level which may be determined easily. Quite often, when a dilution is not performed, the number of microorganisms or the concentration of a solution is too high to be determined by standard methods. A serial dilution will bring a sample within the normal range of analysis.

PREREQUISITES

Before beginning this module you should be able to use standard laboratory equipment and volumetric glassware [Env Sci 101:1(49) and 101:2(49)], and prepare reagents [Chem 101:47j(36)].

RESOURCES

IRIS: 1352

OBJECTIVES

OBJ 1: Prepare laboratory glassware and supplies.

COND: Given an equipped wastewater laboratory.

PL: Include:

a. All glassware washed with detergent, rinsed with tap water and distilled water, and air dried.
b. Pipets, plugged with cotton, sterilized one hour at 170°C.
c. Reagents correctly prepared.

OBJ 2: Perform a serial dilution.

COND: Given resources.

PL: Conditions as stated in resources must be met.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
9 test tubes	x	x						
Test tube rack		x						
0.1N hydrochloric acid (HCl)		x						
0.001N sodium hydroxide (NaOH)		x						
0.02% phenol red		x						
Paper labels		x						
Cotton		x						
8 1 ml pipets		x						
1 pipet bulb		x						
1 eyedropper		x						

Pouring Agar Plates

ENV SCI 101:3b(49)

PURPOSE

This guide will assist you in learning how to pour agar plates, using petri dishes. Petri dishes contain a top cover which overlaps a bottom cover. Air easily enters the dish, but the overlapping edge prevents contaminants from reaching the sterile medium within the dish. Petri dishes are most often used:

1. to observe surface and subsurface growths of bacterial colonies;
2. to isolate an individual bacterial colony from mixtures of colonies;
3. to maintain or cultivate species which require large surface area for growth.

PREREQUISITES

Before beginning this module you should be able to use standard laboratory equipment and volumetric glassware [Env Sci 101:1(49) and Env Sci 101:2(49)] and be able aseptically to prepare culture media [Env Sci 101:4(49)].

RESOURCES

1. "Pour Plate Technique for Isolation of a Pure Culture," audio-visual material prepared by American Institute of Biological Sciences, Project BIOTECH.
2. "How to Pour Agar Plates," audio-visual material prepared by American Institute of Biological Sciences, Project BIOTECH.

OBJECTIVES

OBJ 1: Prepare laboratory glassware and supplies.

COND: Given an equipped wastewater laboratory.

PL: Include:

a. Six nutrient agar pours
b. Two beakers of hot water ($50^{\circ}C$ and $100^{\circ}C$)
c. Six sterile petri dishes
d. Refrigerator

OBJ 2: Aseptically prepare petri dish cultures.

COND: Given an equipped wastewater laboratory and Resource 1.

PL: All cultures should show no growth after incubation at $35^{\circ}C$.

OBJ 3: Pour agar plates.

COND: Given an equipped wastewater laboratory and resources.

PL: The pours should be prepared by melting at $100^{\circ}C$, cooling to $50^{\circ}C$, then incubating for 24 hours. No cultures should develop during this time.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
6 agar pours	x	x	x					
6 petri dishes	x	x	x					
2 1000 ml beakers	x	x	x					
Incubator 35°C		x	x					
Thermometer	x	x	x					
Bunsen burner		x	x					

Streaking Agar Slants and Plates

ENV SCI 101:3c(49)

PURPOSE

This guide will assist you in learning to perform streaking techniques aseptically. The streak plate and streak slant techniques are useful methods for:

1. separating a pure culture from a mixed culture;
2. lowering the population density of an organism;
3. determining if more than one type of organism is present in a dense culture.

PREREQUISITES

Before beginning this module you should be able to prepare and pour culture media [Env Sci 101:3b and f(49)] and be able to perform an aseptic transfer [Env Sci 101:3e(49)].

RESOURCES

(To be provided by instructor.)

OBJECTIVES

OBJ 1: Aseptically prepare four agar pours and two agar slants.

COND: Given an equipped wastewater laboratory and resources.

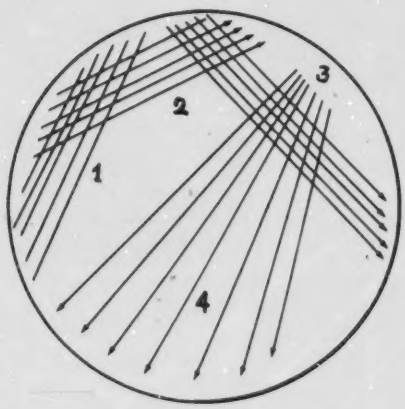
PL: Pours and slants should show no sign of growth after storage in the refrigerator for one day.

OBJ 2: Streak two pour plates using the Quadrant Streak Method.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:

a. Agar surface should not be gouged or broken.
b. Streaked plates should show isolated colonies which have been well separated.
c. Incubated culture should show only those organisms present in the original culture.
d. Pattern on the plates should appear as below:



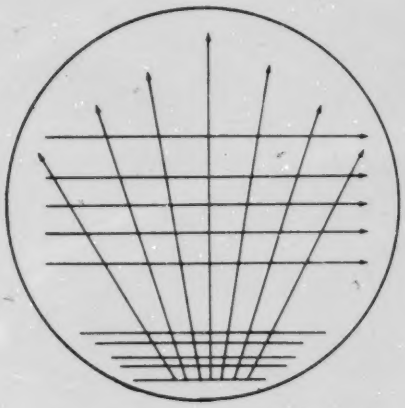
OBJ 3: Streak two pour plates using the Radient Streak Method.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:

a. Agar surface should not be gouged or broken.
b. Streaked plates should show isolated colonies which have been well separated.

c. Incubated culture should show only those organisms present in the original culture.
d. Pattern on the plates should appear as below:



OBJ 4: Streak two slants.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Agar surface should not be gouged or broken.
b. Streaked slant should show isolated colonies which have been well separated.
c. Incubated culture should show only those organisms present in the original culture.
d. Zig-zag pattern should appear on the surface of the agar.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
4 agar plates	x	x	x					
2 slants	x			x				
Inoculating loop		x	x	x				
Mixed culture broth		x	x	x				
Bunsen burner		x	x	x				
Test tube rack	x			x				
Incubator 37°C		x	x	x				
Refrigerator	x							

Aseptic Transfers with Loop

ENV SCI 101:3e(49)

PURPOSE

This guide will assist you in learning to perform pure culture transfers without adding outside contaminating bacteria or infecting yourself and contaminating the lab. Since microbes are present everywhere, it is necessary to use extreme care not to introduce unwanted organisms into a pure culture. Aseptic techniques are techniques which keep outside microorganisms from contaminating your transfer culture.

PREREQUISITES

None

RESOURCES

"The Use of Aseptic Techniques in the Tube Transfer of Bacteria," audio-visual material prepared by American Institute of Biological Sciences, Project BIOTECH.

OBJECTIVES

OBJ 1: Prepare the inoculating loop.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:

a. Correctly holding the loop.
b. Flaming the total wire portion to the loop to redness.
c. Cooling the loop for about 30 seconds.

OBJ 2: Prepare the tubes for transfer.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:

a. Correctly holding the tubes.
b. Correctly removing the caps.
c. Flaming the mouths for 2-5 seconds.

OBJ 3: Aseptically transfer a culture from one tube to another.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:

a. Collecting a small amount of culture on the loop using a side-to-side motion.
b. Avoiding gouging or otherwise penetrating the medium surface.
c. Reflaming the tubes.
d. Replacing the caps on the proper tubes.
e. Reflaming the loop.
f. Performing the exercise outlined in resources.
g. Incubating the transferred culture to insure it is a pure culture of a single species.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
3 agar slants		x	x					
1 culture slant			x					
4 caps		x	x					
1 test tube rack		x	x					
Bunsen burner	x	x	x					
Inoculating loop	x		x					

Preparing Culture Media

ENV SCI 101:3I(49)

PURPOSE

This guide will assist you in learning how to prepare tubes and plates of several different kinds of culture media which will be used in subsequent guides. A *medium* is the food used for culturing microorganisms. *Liquid media* (nutrient broth, glucose broth) can be used for fermentation studies (coliform by MPN), for growth of large numbers of organisms, and for numerous other procedures. *Solid media* (nutrient agar, nutrient gelatin) are used to assist in the isolation of pure cultures and to observe the appearance of surface organisms.

PREREQUISITES

Before beginning this module you should be able to use standard laboratory equipment and volumetric glassware [Env Sci 101:1 and 2(49)].

RESOURCES

1. "Pour Plate Technique for Isolation of a Pure Culture," audio-visual material prepared by American Institute of Biological Sciences, Project BIOTECH.
2. "How to Pour Agar Plates," audio-visual material prepared by American Institute of Biological Sciences, Project BIOTECH.

OBJECTIVES

OBJ 1: Check adjustment of laboratory equipment.

COND: Given an equipped wastewater laboratory.

PL: Include:
- a. Autoclave
- b. Water distillation apparatus
- c. Hot plate
- d. pH meter
- e. Balance

OBJ 2: Prepare glassware and supplies.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
- a. All glassware washed with detergent, rinsed with tap water and distilled water, and dried with air. (Do not towel dry.)
- b. Adjusted autoclave.
- c. Calibrated pH meter.

OBJ 3: Prepare a batch of nutrient agar.

COND: Given an equipped wastewater laboratory, resources, and the label on the dehydrated nutrient agar bottle.

PL: Include:
- a. Media will be prepared in the correct proportions by weight.
- b. pH will be adjusted.
- c. Agar will not char.
- d. Agar will be poured into test tubes by means of a dispensing funnel.

OBJ 4: Prepare a batch of nutrient broth.

COND: Given an equipped wastewater laboratory, resources, and the label on the dehydrated nutrient broth bottle.

PL: Include:

a. Media will be prepared in the correct proportions by weight.
b. pH will be adjusted.
c. Nutrient broth will be poured into test tubes with caps.

OBJ 5: Sterilize the media.

COND: Given an equipped wastewater laboratory and autoclave directions.

PL: Include:

a. Proper operation of the autoclave must be demonstrated, including necessary corrections for temperature and pressure.
b. Sterilized media should show no signs of growth after refrigeration for 48 hours.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Autoclave	x	x			x			
pH meter	x	x	x	x				
Water distillation apparatus	x	x	x	x				
Hot plate	x	x	x	x				
Balance	x	x	x	x				
Test tubes (20 mm diameter)		x	x	x	x			
Caps for test tubes		x	x	x	x			
Stirring rod		x	x	x				
Nutrient agar (dehydrated)			x					
Nutrient broth (dehydrated)				x				
Test tube wire basket			x	x	x			
Refrigerator					x			
Thermometer			x	x				

Counting Colonies and Making Total Counts

ENV SCI 101:3g and d(49)

PURPOSE

This guide will assist you in learning a method for determining the total number of living microorganisms in a sample. The total count is a gross indicator of overall bacteriological quality. The techniques involved are common to more specific water quality tests.

PREREQUISITES

Before beginning this module you should be able to use standard laboratory equipment and volumetric glassware [Env Sci 101:1 and 2(49)], be able to prepare and pour culture media [Env Sci 101:3b and f (49)], and be able to perform a serial dilution [Env Sci 101:3a(49)].

RESOURCES

IRIS: 1414

OBJECTIVES

OBJ 1: Perform a proper serial dilution on the practice sample.

COND: Given resources and an equipped wastewater laboratory.

PL: Conditions stated in IRIS 1414 must be met. Include:

a. Final result should be checked by indicator (only two solutions should be pink).
b. Correct numbering of dilutions.
c. Each dilution must be completely mixed.

OBJ 2: Perform a proper serial dilution on a tube of nutrient broth culture.

COND: Given an equipped laboratory.

PL: Include:

a. Each dilution must be completely mixed before it is used to make subsequent dilutions.
b. Each dilution must be labeled.
c. Conditions stated in resources must be met.
d. Cultures made from these dilutions and incubated at 37°C for 24-48 hours should show the effects of the dilution (i.e., there should be a gradient in population density with the greatest dilution showing the smallest population).

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
1 tube nutrient broth culture		x						
18 test tubes	x	x						
1 150 ml bottle with cap	x							
0.1N hydrochloric acid (HCl)	x							
0.001N sodium hydroxide (NaOH)	x							
0.02% phenol red	x							
Rubber suction bulb	x	x						
3 5 ml pipets	x	x						
18 1 ml pipets	x	x						
9 agar petri dishes		x						
Incubator 37°C		x						
Colony counter		x						

Bacteriological Sample Container Preparation

ENV SCI 101:4(49)

PURPOSE

This guide will assist you in preparing containers for bacteriological samples. Bacteriological samples must contain only those organisms associated with the source of the sample. Therefore, the sample container must be kept sterile until the sample is taken.

PREREQUISITES

Before beginning this module you should have successfully completed [Env Sci 101:1a and j(49)]; [Env Sci 101:2a-c(49)]; [Chem 101:46e and f(36)]; [Chem 101:47j (36)].

RESOURCES

IRIS: 4, 2558, 2559

OBJECTIVES

OBJ 1: Select and clean sample containers.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Bottle size at least 100 ml capacity. The following steps performed:

a. Bottle washed with detergent.
b. Rinsed with hot water.
c. No chipped, cracked, scratched or etched bottles or caps selected.
d. Rinsed with distilled or deionized water.

OBJ 2: Prepare 10% sodium thiosulfate solution.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Solution with 10% sodium thiosulfate ± 1%.

OBJ 3: Add sodium thiosulfate to sample bottle.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Thiosulfate added at rate of 0.1 ml ± 0.02 ml per 100 ml container.

OBJ 4: Cover stoppered bottle with covering material.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Not more than 2% of coverings fall off when turned upside down after autoclaving.

OBJ 5: Autoclave sample bottles.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Temperature maintained at 121°C for 15 minutes.

OBJ 6: Select marker and attach labels.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Marker must be a nonsmearing, permanent type. Labels must be clean and unused. A sharp tug on label should not detach it from bottle.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Autoclave, providing uniform temperatures up to and including 121°C.					x			
Balance, 0.1 g sensitivity at a load of 150 g		x						
Apron	x	x	x	x	x	x		
Bottles, sample, 250 ml wide mouth, glass stopper	x		x	x	x	x		
Jar (to receive used pipets)		x	x					
Pipets, 1 ml with 0.1 ml graduation (Mohr type)		x	x					
Pencils, china-marking, wax						x		
Metal foil or heavy paper or rubberized cloth, milk bottle cap				x	x	x		
Detergent	x							
Bottle brush	x							
Deionized or distilled water	x							
Labels and cord						x		
Volumetric flask, 100 ml		x						
Weighing dish		x						
Spatula		x						
Sodium thiosulfate ($Na_2S_2O_3$)		x						

Bacteriological Sample Collection

ENV SCI 101:5(50)

PURPOSE

This guide will assist you in learning the correct technique for collection of a bacteriological sample. Bacteriological samples must be representative of their source. Care must be taken that the sample is not contaminated during its collection.

PREREQUISITES

None

RESOURCES

IRIS: 4, 2558, 2559

OBJECTIVES

OBJ 1: Collect and check condition of sampling equipment.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Include:
- a. Sampling device
- b. Germicide for emergencies
- c. Rubber gloves
- d. Ice chest

OBJ 2: Select point for sample.

COND: Field location and resources (IRIS 2559).

PL: Include:
- a. Service line flushed for at least 3 minutes or until line clears.
- b. Direction of flow determined for stream.
- c. If no flow evident, position taken to minimize contamination.

OBJ 3: Take sample

COND: Given sample containers, sample location, and resources (IRIS 2559).

PL: Include:
- a. Bottle and cap not contaminated.
- b. Bottle 3/4 full.
- c. Labeled with required information.
- d. Top sealed with covering.
- e. Placed in ice chest.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Prepared sample bottles	x		x					
Germicide	x		x					
Rubber gloves	x		x					
Ice chest	x		x					
Sampling device	x		x					

Transporting and Storing of Bacteriological Samples

ENV SCI 101:6,7(50)

PURPOSE

This guide will assist you in learning how to correctly transport and store a bacteriological sample. Bacteriological samples must be transported and stored under proper conditions to assure validity of results. Time delays or warm temperatures will invalidate these results.

PREREQUISITES

None

RESOURCES

IRIS: 4, 2558, 2559

OBJECTIVES

OBJ 1: Describe the procedure for transporting to the laboratory and storing a bacteriological sample in the laboratory.

COND: Given resources (IRIS 2559).

PL: Include:

a. Desirable and maximum time from sampling to storage in laboratory.
b. Desirable and maximum time in storage before analysis.
c. Type of container for storage during transportation.
d. Temperature inside transporting container.

OBJ 2: Transport samples to laboratory.

COND: Given samples, equipment, and resources (IRIS 2559).

PL: 95% of samples arriving at the laboratory must be suitable for analysis.

OBJ 3: Store samples.

COND: Given samples, equipment, and resources (IRIS 2559).

PL: 95% of samples stored must be suitable for analysis.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Samples		x	x					
Ice chest		x						
Refrigerator (2°-10°C)			x					

Selection of Sample Locations for Bacteriological Analysis

ENV SCI 101:8(50)

PURPOSE

This guide will assist you in learning how to select sample locations for bacteriological analysis. Process control or legal requirements dictate that bacteriological samples be analyzed from a number of locations.

PREREQUISITES

None

RESOURCES

1. Plant operational guide
2. NPDES permit

OBJECTIVES

OBJ 1: Select appropriate sample location in a treatment plant or on watercourse for bacteriological samples.

COND: Given Resource 1 and Resource 2, and the reason for sample, including:

a. Determining efficiency of process.
b. Meeting a regulatory requirement.
c. Meeting a process requirement.

PL: Include:

a. Location in plant or on watercourse.
b. Location in process unit.
c. Location on watercourse cross section.
d. Depth.

EQUIPMENT AND SUPPLIES

None

Fecal Coliform Analysis

ENV SCI 101:9 and 10(50-51)

PURPOSE

This guide will assist you in performing the multiple dilution tube method for fecal coliform analysis, the test procedure acceptable to the U.S. Environmental Protection Agency.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 101:1-8(49-50).

RESOURCES

IRIS: 4, 2558, 2559

OBJECTIVES

OBJ 1: Check adjustment of laboratory equipment.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Include:
- a. Air incubator
- b. Incubator waterbath
- c. Oven, hot air
- d. Water distillation apparatus
- e. Autoclave
- f. pH meter
- g. Balance

OBJ 2: Prepare laboratory glassware and supplies.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Include:
- a. All glassware washed with detergent, rinsed with tap water and distilled water, and air dried.
- b. Pipets, plugged with cotton, sterilized one hour at 170°C.
- c. Dilution water blanks.
- d. Lactose broth.
- e. EC broth
- f. Laboratory data sheets

OBJ 3: Inoculate samples.

COND: Given an equipped wastewater laboratory, resources (IRIS 2559), and samples.

PL: Include:
- a. Labeling culture tubes.
- b. Filling out data sheet.
- c. Disinfecting lab bench before and after inoculation.
- d. Inoculating of tubes.
- e. Placing racks in incubator.
- f. Cleaning glassware.

OBJ 4: Tabulate results after 24 hours ± 2 hours.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Include:
- a. Readings made within 24 ± 2 hours.
- b. Proper incubation temperature and humidity in incubator.
- c. Tubes shaken before reading.
- d. Gas production evaluated.

OBJ 5: Transfer positive samples at 24 hours.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Include:

a. EC broth tubes labeled, data recorded.
b. Sterile transfer made.
c. Lactose tubes returned to 35°C incubator.
d. EC tubes placed in waterbath incubator.
e. Used glassware sterilized and cleaned.
f. Disinfection of lab bench before and after.

OBJ 6: Transfer positive samples at 48 hours.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Include:

a. Readings made within 24 ± 2 hours.
b. Proper incubation temperature and humidity in incubator.
c. Tubes shaken before reading.
d. Gas production evaluated.
e. EC broth tubes labeled, data recorded.
f. Sterile transfer made.
g. Lactose tubes returned to 35°C incubator.
h. EC tubes placed in waterbath incubator.
i. Used glassware sterilized and cleaned.
j. Disinfection of lab bench before and after.

OBJ 7: Read EC broth tubes.

COND: Given an equipped wastewater laboratory and resources (IRIS 2559).

PL: Include:

a. Recording data.
b. Tubes shaken before reading.
c. Gas production evaluated.
d. Used glassware sterilized and cleaned.
e. Disinfection of lab bench before and after.

OBJ 8: Describe and perform the data analysis.

COND: Given laboratory data and MPN code sheets.

PL: 90% calculated correctly.

a. MPN
b. Geometric mean

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Air incubator, 35°C ± 0.5°C	x		x	x	x	x		
Incubator, waterbath to operate at 44.5° ± 2°C	x				x	x	x	
Oven, hot-air sterilizing, 160°-180°C	x	x	x					
Water distillation apparatus	x	x	x					
Autoclave, 121°C	x	x	x		x	x	x	
pH meter, accurate 0.1 pH unit	x	x						
Balance, 0.1g sensitivity at load of 160g	x	x						
Apron or lab coat		x	x	x	x	x	x	
Baskets, wire		x	x		x	x	x	
Bottles, dilution, 6 oz. screw caps with 99 ml line		x	x					
Bottle squeeze type		x	x					
Burner, gas Bunsen		x	x		x	x		
Cans, pipet, aluminum		x	x					
Metal caps, for 20 x 150 ml tubes		x	x					
Jar		x	x					
Inoculation 100, 3 mm diameter		x	x		x	x		
Pipets, 1 ml with 0.1 ml gradation (Mohr type)		x	x					
Racks, culture types 10 x 5 openings		x	x	x	x	x	x	
Sponge		x	x	x	x	x	x	
Tubes, culture 150 x 18 mm		x	x	x	x	x	x	

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Tubes, fermentation, 75 x 10 ml vials		x	x	x	x	x	x	
Distilled water		x	x		x	x	x	
EC broth		x	x		x	x		
Lactose lauryl sulfate tryptose broth		x	x					
Potassium dihydrogen phosphate (KH_2PO_4)		x	x					
Disinfectant		x	x	x	x	x	x	
Wax pencils (Blaisdell 169T)		x	x		x	x		
Data sheets		x	x	x	x	x	x	x
MPN code sheets								x

Fecal Streptococcal Analysis

ENV SCI 101:9 and 10(50-51)

PURPOSE

This guide will assist you in learning how to conduct the fecal streptococcal test. Fecal streptococci are pathogenic and common to animals and man, and thus are indicators of fecal contamination. This test is often used in conjunction with other tests for fecal organisms as an indicator of contamination.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 101:1-8(49-50).

RESOURCES

IRIS: 4

OBJECTIVES

OBJ 1: Check adjustment of laboratory equipment.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:

a. Air incubator
b. Oven, hot air
c. Water distillation apparatus
d. Autoclave
e. pH meter
f. Balance

OBJ 2: Prepare laboratory glassware and supplies.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:

a. All glassware washed with detergent, rinsed with tap water and distilled water, and air dried
b. Pipets plugged with cotton, sterilized one hour at 170°C
c. Dilution water blanks
d. Azide dextrose broth
e. Ethyl videt azide broth
f. Inoculating loops
g. Pipet cans
h. Fermentation tubes
i. Sample bottles
j. Detergent
k. Distilled water
l. Water
m. Kraft paper
n. String
o. Dilution water
p. Data sheets
q. Marking pencil
r. Disinfectant
s. Sponge
t. Racks (test tube)

OBJ 3: Inoculate samples.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:

a. Labeling culture tubes.
b. Filling out data sheet.
c. Disinfecting of lab bench. before and after inoculation.
d. Inoculation of tubes.
e. Placing racks in incubator.
f. Used glassware sterilized and cleaned.

g. Disinfection of lab bench before and after procedure

OBJ 4: Tabulate results after 24 hours ± 2 hours and 48 hours ± 3 hours.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Evaluation of turbidity in tubes.
b. Recording data.

OBJ 5: Transfer positive samples.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Transfer of sample to ethyl violet azide broth.
b. Second transfer if no growth at 24 ± 2 hours.
c. Incubate samples at 35 ± 0.5°C.
d. Used glassware sterilized and cleaned.
e. Disinfection of lab bench before and after procedure

OBJ 6: Read ethyl violet azide broth tubes.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Read tubes.
b. Record data.
c. Used glassware sterilized and cleaned.
d. Disinfection of lab bench before and after procedure.

OBJ 7: Describe and perform the data analysis.

COND: Given lab data, MPN code sheets.

PL: 90% of MPN's calculated correctly.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES 1	2	3	4	5	6	7	8
Air incubator	x							
Oven, hot air	x							
Water distillation apparatus	x							
Autoclave	x							
pH meter	x							
Balance	x							
Dilution bottles		x	x					

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES							
	1	2	3	4	5	6	7	8
Sample bottles		x	x					
Fermentation tubes		x	x		x	x		
Soap		x	x		x	x		
Water		x	x		x	x		
Distilled water		x	x		x	x		
Cotton		x						
Kraft paper		x						
String		x						
Pipet cans		x	x					
Dilut'on water		x	x					
Inoculating loops		x	x		x			
Data sheets		x	x	x	x	x	x	
Marking pencils		x	x		x	x		
Disinfectant		x	x		x	x		
Sponge		x	x		x	x		
Racks (test tube)		x	x		x	x		
Azide dextrose broth		x	x					
Ethyl violet azide broth		x			x			

Total Coliform (MPN) Test

ENV SCI 101:9 and 10

PURPOSE

This guide will assist you in learning to perform a total coliform test, which is often used to determine the bacteriological quality of drinking water. It gives an indication of the possible contamination of the water by animal and human feces.

PREREQUISITES

Before beginning this module you should have successfully completed Env Sci 101:1-8(49-50).

RESOURCES

IRIS: 4

OBJECTIVES

OBJ 1: Check adjustment of laboratory equipment.

COND: Given an equipped wastewater laboratory and resources.

PL: Include correct check of:
- a. Air incubator
- b. Oven, hot air
- c. Water distillation apparatus
- d. Autoclave
- e. pH meter
- f. Balance
- g. Colony counter
- h. Microscope

OBJ 2: Prepare laboratory glassware and supplies.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
- a. All glassware washed with detergent, rinsed with tap water and distilled water, and air dried:
  1. dilution bottles and tubes
  2. petri dishes
  3. fermentation tubes and vials
  4. sample bottles
  5. glass slides
- b. Glassware plugged, wrapped or canned, and sterilized one hour at 170°C
- c. Dilution water
- d. Lactose broth
- e. Lauryl tryptose broth
- f. Brilliant green lactose bile broth
- g. Endo agar
- h. EMB agar
- i. Nutrient agar
- j. Inoculating equipment
- k. Pipet containers
- l. Hucker's solution
- m. Lugol's solution
- n. Counter stain
- o. Acetone, alcohol
- p. Laboratory data sheets

OBJ 3: Inoculate samples.

COND: Given an equipped wastewater laboratory, resources, and samples.

PL: Include:
- a. Labeling culture tubes.
- b. Filling out data sheet.
- c. Disinfecting lab bench before and after inoculation.
- d. Inoculating tubes.

e. Placing racks in incubator.
f. Cleaning glassware.

OBJ 4: Tabulate results after 24 hours ± 2 hours.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Readings made within 24 hours ± 2 hours.
b. Proper incubation temperature and humidity in incubator.
c. Tubes shaken before reading.
d. Gas production evaluated.

OBJ 5: Transfer positive samples at 24 ± 2 hours.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Broth tubes read, data recorded.
b. Sterile transfer made to brilliant green lactose bile.
c. Broth tubes returned to incubator.
d. Brilliant green tubes placed in 35°C incubator.
e. Used glassware sterilized and cleaned.
f. Disinfection of lab bench before and after transfer.

OBJ 6: Transfer positive samples at 48 hours.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Broth tubes read, data recorded.
b. Sterile transfer made to brilliant green lactose bile.
c. Broth tubes returned to incubator.
d. Brilliant green tubes placed in 35°C incubator.
e. Used glassware sterilized and cleaned.
f. Disinfection of lab bench before and after transfer.

OBJ 7: Streak Endo or EMB plates.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Sterile transfer of sample.
b. Streaking plate.
c. Incubate plates at 35°C.
d. Used glassware sterilized and cleaned.
e. Disinfection of lab bench before and after procedure.

OBJ 8: Prepare cultures for gram stain.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Transfer typical colonies to broth and nutrient agar slant.
b. Incubate 35°C for 24 or 48 hours.
c. Used glassware sterilized and cleaned.
d. Disinfection of lab bench before and after procedure.

OBJ 9: Carry out gram stain.

COND: Given an equipped wastewater laboratory and resources.

PL: Include:
a. Transfer growth to distilled water and fix.
b. Stain and counter stain.
c. Examine under microscope.
d. Used glassware sterilized and cleaned.
e. Disinfection of lab bench before and after procedure.

OBJ 10: Describe and perform data analysis.

COND: Given laboratory data, MPN code sheets, and resources.

PL: 90% of MPN's calculated correctly.

EQUIPMENT AND SUPPLIES

ITEM	OBJECTIVES									
	1	2	3	4	5	6	7	8	9	10
Air incubator	x	x	x	x	x	x	x	x		
Oven, hot air	x	x	x	x	x	x	x	x		
Water distillation apparatus	x	x								
Autoclave	x	x	x	x	x	x	x	x		
pH meter	x	x								
Balance	x	x								
Colony counter	x	x						x	x	
Microscope	x	x							x	
Dilution bottles and tubes		x	x							
Petri dishes		x					x			
Fermentation tubes and vials		x	x	x						
Sample bottles		x	x							
Soap		x	x	x	x	x	x	x	x	
Water		x	x	x	x	x	x	x	x	
Distilled water		x	x	x	x	x	x	x	x	
Cotton		x								
Kraft paper		x								
String		x								

EQUIPMENT AND SUPPLIES (continued)

ITEM	OBJECTIVES									
	1	2	3	4	5	6	7	8	9	10
Pipet cans		x	x							
Petri dish cans		x								
Dilution water		x	x							
Lactose broth		x	x					x		
Lauryl tryptose broth		x	x							
Brilliant green lactose broth		x								
Endo agar		x					x			
EMB agar		x					x			
Nutrient agar		x						x		
Inoculating equipment		x	x	x	x	x	x	x	x	
Hucker's solution		x							x	
Lugol's solution		x							x	
Counter stain		x							x	
Acetone, alcohol		x							x	
Data sheets		x	x	x	x	x	x	x	x	x
Marking pencil		x	x		x	x		x		
Disinfectant			x		x	x	x	x	x	
Sponge			x		x	x	x	x	x	
Racks (test tube)		x	x		x	x			x	
Glass slides									x	

Appendix I
IRIS RESOURCES

CODE DEFINITIONS

AC	audio tape cassette	OT	overhead transparency
FS	35mm filmstrip	PM	printed matter
MP	motion picture	SL	35mm slide

NUMBER	TITLE	SOURCE/AUTHOR	TYPE OF MATERIAL
4	Standard Methods for the Examination of Water and Wastewater	WPCF	PM
41	AWWA Standard for Sodium Chloride	AWWA	PM
60	AWWA Standard for Sodium Fluoride	AWWA	PM
108	Supervisors Workshop	NFI	PM
125	Operation of Wastewater Treatment Plants	WPCF	PM
142	Analysis of Wastewater Samples	NY Dept. of Health	PM SL
281	Supervisory Problems Workshop and Reference Manual	DuPont	PM
282	Temperature Measurement Basic Physics and Terms	DuPont	PM
283	Temperature Measurement Scales and Conversion	DuPont	PM
284	Temperature Measurement Thermometers	DuPont	PM
285	Titration and ITS Glassware	DuPont	PM
289	Water Treatment - Water Chemistry	DuPont	PM
291	Water Treatment - Water Testing	DuPont	PM
381	Office Management	Lansford	OT
399	Technical Report Writing (out of print)	Lansford	OT
404	Fundamentals of Analytical Chemistry	Lansford	OT
413	Determination of Alkalinity	EPA	AC PM SL
466	Alkalinity	EPA	AC PM SL

NUMBER	TITLE	SOURCE/AUTHOR	TYPE OF MATERIAL
480	Our Environment Battles Water Pollution	Renn, C. E.	PM
481	Study of Water Quality	Renn, C. E.	PM
488	Investigating Water Problems - A Water Analysis Manual	Renn, C. E.	PM
538	Atomic Absorption	EPA WPO	AC PM SL
539	Chemical Oxygen Demand	EPA	AC PM SL
540	Dissolved Oxygen Determination	EPA	AC PM SL
542	Determination of Phosphorus	EPA	AC PM SL
547	Operational Control Tests for Activated Sludge Process - Part 3	EPA	AC PM SL
556	Residual Chlorine and Chlorine Demand	EPA	AC PM SL
557	Determination of Chemical Oxygen Demand	EPA	AC PM SL
618	Water Measurement Manual	Interior Dept.	PM
771	Determination of Total Organic Carbon	EPA	AC PM SL
830	Recommended Standards for Sewage Works - Ten State Standards	NY HES	PM
850	Use of Spectromic 20 Spectrophotometer	EPA	AC PM SL
879	Practical Guide to Water Quality Studies of Streams	Kittrell, F. W.	PM
902	Determination of Suspended Solids	EPA	AC PM SL
1017	Control of Sulphides in Sewerage Systems	Thistlelkwayte, D.	PM
1027	Applied Chemistry of Wastewater Treatment - Unit 8 - Applications - pH and Alkalinity	Mancy, K. H.	PM
1036	Water Quality Instrumentation, Vol. 2	Scales, J. W.	PM
1060	Sartorius Balance 2400	Slabaugh, W. H.	MP
1061	Colorimetry - Part I	Slabaugh, W. H.	MP
1062	Colorimetry - Part II	Slabaugh, W. H.	MP
1063	pH Meter	Slabaugh, W. H.	MP
1143	Titration	Kalmia	MP

NUMBER	TITLE	SOURCE/AUTHOR	TYPE OF MATERIAL
1226	Writing Letters That Get Results	Roundtable	MP
1331	Biological Field Investigative Data for Water Pollution Surveys (out of print)	Ingram	PM
1332	Biological Associated Problems in Freshwater Environments - Their Identification, Investigation and Control	Mackenthun	PM
1352	How to Make Serial Dilutions	AIBS	AC FS PM SL
1363	How to Measure Water Hardness	AIBS	AC FS PM SL
1370	Laboratory Procedures - Analysis for Wastewater Treatment Plant Operators	Wietti, D.	PM
1413	How to Measure Dissolved Oxygen Content of Water	AIBS	AC FS PM SL
1414	How to Grow and Count Microorgansims on Membrane Filters	AIBS	AC FS PM SL
1426	Treatment and Disposal of Wastewater Sludges	Wesilind, P. A.	PM
1429	Atomic Spectrometric Analysis of Heavy Metal Pollutants in Water	Burrell, D. C.	PM
1505	Introduction to Environmental Technology - Vol. I of Wastewater Technology	Clemson University	PM
1506	Plant Operations for Wastewater Facilities - Vol. II of Wastewater Technology	Clemson University	PM
1583	Office Records Management	Lansford	OT
1755	Water Quality Parameters	ASTM	PM
1762	pH Meter - Laboratory Operation	EPA	AC PM SL
1795	Modern Chemical Technology - Vol. 5	ACS	PM
1823	Water Use Classifications and Standards of Water Quality	NEIWPCC	PM
1886	Temperature Measurement - Standards and Calibration	DuPont	PM
1915	Wastewater Treatment Technology	Patterson, J. W.	PM

NUMBER	TITLE	SOURCE/AUTHOR	TYPE OF MATERIAL
2075	Processing Water Treatment Plant Sludge	AWWA	PM
2105	Common Laboratory Apparatus	Comm Skill	AC FS PM SL
2106	Pipetting Techniques	Comm Skill	AC FS PM SL
2110	pH Measurements	Comm Skill	AC FS PM SL
2116	Temperature	Mitchel, J. P.	AC FS PM SL
2122	pH, pOH and Buffers	Mitchell, J. P.	AC FS PM SL
2127	Dilution and Titration Problems	Mitchell, J. P.	AC FS PM SL
2134	Basic Relationships and Instrumentation Basic Gas Chromatography	McNair, H. M.	AC FS PM SL
2135	Column ITS Make Up and Use	McNair, H. M.	AC FS PM SL
2136	Detectors - Design and Use	McNair, H. M.	AC FS PM SL
2137	Sample Preparation Derivatives and Sampling Technique	McNair, H. M.	AC FS PM SL
2138	Column Temperature Programming	McNair, H. M.	AC FS PM SL
2139	Qualitative and Quantitative Analysis	McNair, H. M.	AC FS PM SL
2141	Derivatives for Gas Chromatography	McNair, H. M.	AC FS PM SL
2143	Principles of Atomic Absorption	Robinson, J. W.	AC FS PM SL
2144	Instrumental Requirements - Basic Atomic Absorption Spectroscopy Series	Robinson, J. W.	AC FS PM SL
2145	Optimizing Instrument Conditions - Basic Atomic Absorption Spectroscopy Series	Robinson, J. W.	AC FS PM SL
2146	Sample Preparation and Special Sampling Techniques	Robinson, J. W.	AC FS PM SL
2302	Basic Principles of the Analytical Balance	USPHS	MP
2510	Management and Supervision Procedures for Wastewater Facilities - Vol. IV of Wastewater Technology	Clemson University	PM
2534	Safety Pipetting	USNMAC	MP
2558	Self-Monitoring Procedures - Basic Parameters for Municipal Effluents - Staff Guide	EPA	PM

NUMBER	TITLE	SOURCE/AUTHOR	TYPE OF MATERIAL
2559	Self-Monitoring Procedures - Basic Parameters for Municipal Effluents - Student Reference Manual	EPA	PM
2575	Hardness of Drinking Water and Public Health	Amavis, R.	PM
2758	Stream - Gauging Procedures	Corbett, D. M.	PM
2759	Field Manual for Research in Agricultural Hydrology	Holtan, H. M.	PM
2911	Basic Laboratory Techniques for NPDES	Bonnette, A. K., Lamb, D., Allen, J. F.	PM